

Solid waste  
management the  
most important  
element constituting  
the environmental ...



**Abstract**

Solid Waste Management is perhaps one of the most important element constituting the environmental health and sanitation of urban developing sector. The management system has several components which are integrated as well as interdependent thus the efficiency and effectiveness of the entire system is affected when any of its functional component fails or does not perform up to the level mark of operation.

Karachi metropolis has been growing in population and expanding in area since mid 1800s. The present estimated population has reached over 18 million with approximate daily generation of solid waste reaching quantities up to 9000 tonnes. There are 18 municipal administrative divisions (TMA) and in addition 4 cantonment areas in Karachi which are responsible for managing solid waste in their respective jurisdictions. Prior to administrative devolution (2001) Karachi Municipal Corporation (KMC) was responsible for the management of solid waste of the entire city. It is estimated that nearly 80% of the municipal solid waste is being collected and transported to the two designated disposal sites as proper sanitary landfill sites are yet to develop. Hence there has been an improvement in the waste collection and transportation system since 90s when only 2/3rd of the municipal waste was managed. The transportation mechanism is through garbage vehicles using either hauled or fixed container system employing crew for mechanical or manual loading. The number of garbage vehicles is inadequate and due to comparatively long haulage to disposal sites there are certain problems of frequent vehicular maintenance and high fuel costs.

The role of informal sector in collection of waste from streets and removal of recycling items from the solid waste stream is significant. However this unaccounted component needs to be acknowledged and integrated in the formal solid waste management system.

Hospital waste is another significant component to have environmental and health impact on the urban society. In Karachi around 30% of the total MSW may be regarded as of hospital origin out of which 0.6 tons per day is infectious. At source segregation practice is exercised at most hospitals and laboratories with few large private and public hospitals having their own in-house disposal facilities, incineration units. City district government has also facilitated centralised incineration operation for public and private hospitals (health care units) through private contract having a capacity of 1000 kg/hour.

Improvement schemes have been proposed for Karachi solid waste management system. There is a need to adopt engineered approach in the redesigning of existing system such as; community bins and receptacles have to be designed and constructed for adequate storage capacities according to the generation rates, collection frequencies and safety requirements to control disease vector, over spilling and check unwanted access of waste-pickers. In most of the towns street sweeping operations have been mechanised and done by machinery operated by vehicles. Construction of Garbage Transfer Stations (GTS) at number of locations within the city will cut the cost of transportation of waste to disposal sites as long haulages will be reduced. Material processing, recovery of recyclables, compaction, volume reduction, and increase in density will enable  
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transportation of waste to disposal sites / landfills via long vehicles (bulk transport), minimising transport/traffic and environmental pollution related issues. Development of disposal sites into proper sanitary landfill sites are being considered and appropriate budgeting and planning is underway.

Integration of informal (micro level) and formal (macro level) waste management system is envisaged to be a plausible working solution for an efficient and sustainable system achieved through integration of primary collection system and waste recycling adopted from informal system.

It may be concluded that solid waste management system is undergoing a change over time due to constructive approach, positive policy and decision making. However more concrete steps are to be taken beyond planning stage. The impact of SWM on the environment and aesthetics of Karachi's urban scenario have been significant due to growing and expanding city and also owing to administrative transformations occurring over decades. The shortcomings in the SWM system of Karachi are being gradually met and it is envisaged that if the ' political will' is sustained it will soon meet its present requirements as well as shall be able to cater the future demands of the city.

## **Introduction**

The title of this research paper is very profound, diversified and intricate when addressed particularly in context to the demographic features of the Karachi metropolis, quantities and characteristics of solid wastes, the prevailing issues of management system and practices of solid waste disposal in the city. Though it is difficult to encompass and comment on all the aspects in detail but an attempt has been made to highlight the most

critical issues and recommend possible measures for improving the existing solid waste management system.

### **Statement of the Research Problem**

Solid waste management (SWM) is an integral component of urbanisation and infrastructure development of cities and becomes more essential and critical in the domain of mega cities which are rapidly growing and expanding. The planning and design of solid waste management system which comprise of its components; storage, collection, transfer, transport, processing and disposal requires detailed studies, extending from physical surveys, demographic and socioeconomic data collection, solid waste generation estimates and characterisation analyses, various options for processing and disposal and finally technical and financial analysis for implementation and operation of the system.

The present study is limited to defining basic components of SWM system that are functioning in Karachi. The problems and issues of the existing SWM of Karachi need to be identified with the suggestions of possible solutions for the improvement in functioning and effectiveness of the system.

### **Hypothesis**

The hypothesis of the issue of solid waste management of Karachi can be expressed as sustained deficit in meeting the physical requirement of resources due to unprecedented growth in urban population resulting in uncontrolled and increasing quantities of solid waste continuously requiring restructuring of the management system, procurement and reallocation of

physical and human resources and development of infrastructure which has not yet been achieved due to lack of priority and financial constraints.

### **Significance of the Research**

The paper provides an overview of the general aspects of solid waste management in urban sector. The case study of Karachi shall be discussed in context to the functions of the SWM components and their infrastructure in effective removal and disposal of solid waste. The issues and problems associated with the management, operations and policy making is highlighted which will be significant to serve the purpose of this research document as well to serve as a baseline for further research in the area.

### **Research Methodology**

The adopted methodology is simple yet comprehensive in defining and achieving the objectives of the research. The research statement has been laid so as to address the problem, issues and objectives of the research study. The scope of the study has been clearly delineated based on the objectives of research. A brief review of relevant literature encompassing scope and its research has been undertaken leading to identification of paramount issues with an analytical approach to problem solving in solid waste management.

The conclusion outlines remedial measures, solution and recommendations for an integrated approach to Solid Waste Management in Karachi.

### **Historical Background and Existing Scenario**

A substantial increase in the solid waste production, particularly municipal solid waste (MSW) has been observed over the past few years from nearly 6,

600 tons per day in late 90s to 9, 000 tons/day of solid waste being generated in the city of Karachi in 2005 (KSDP 2020).

For over a half century, Karachi Metropolitan Corporation (KMC) has been administering the management of municipal solid waste of Karachi. After the devolution of the administrative structure in August 2001, the above service fell under the City District Government of Karachi (CDGK). Solid Waste Management within the City District is the combined responsibility of CDGK, the Town Municipal Administrations (TMAs) and Union Councils.

Present City District Government Karachi (CDGK) has 18 towns and altogether 178 union councils. Each union council is responsible for providing waste collection services to an average of 9, 500 households which is considered to be an ideal load for the management of municipal solid waste efficiently and effectively within its jurisdiction. In addition, the Cantonment Boards, Karachi Port Trust and Pakistan Steel Mills carry out their own waste collection and transfer. The key agencies responsible for collection are the TMAs, who either use their own equipment or contract private sector operators in managing and operating the primary collection system. In many low income areas community based organisations (CBOs) are active in collection from households and transfer of MSW to community bins or katchra kundi. Also in many areas sweepers are operative and have organised to collect garbage from residences, neighbourhood and communal streets. Few high-income areas have house-to-house collection organised by appropriate garbage vehicles that transport refuse to disposal sites. There is an average population of about 560, 000 coming under town administrations that are responsible for collecting and transporting solid waste to designated <https://assignbuster.com/solid-waste-management-the-most-important-element-constituting-the-environmental-health/>

' landfill' site. District government is liable to provide and develop landfill site(s) for the city of Karachi at appropriate locations. It should also manage and operate those sites. Presently, there is as such no sanitary landfill site for Karachi. Only couple of designated pieces of land have been allocated for dumping of solid waste on daily basis. The CDGK is responsible for the maintenance and operation of the two " official" open disposal sites at Jam Chakro and Gond Pass – each 35 km from the city centre. Any landfill developmental activity or standard sanitary operation practice on these dumping sites is yet to be carried out.

it is estimated that of the total household solid waste generated daily within the City District around 4, 500 tons is lifted and of this, not more than 2, 000 tons makes it to one of the two designated city " landfill" sites – actually open dumping sites. The remainder is either recovered for recycling (an estimated 1, 500 tons per day) or is disposed of by burning or by illegal dumping into open drains or onto roadsides or open land (an estimated 1, 400 tons)[1]. It is estimated that some 55, 000 families depend on the informal solid waste recycling industry for their livelihood and with more than 1, 000 operating units that the industry is worth some Rs 1. 2 Billion per annum[2].

Hospital (infectious) wastes are co-disposed with the regular solid waste stream. The availability of incineration facilities is on a very limited scale hence most hospital waste is co-disposed with general waste, representing a significant health risk. Onsite incineration facility is available in 3 to 4 major hospitals operating in public and private sector. However CDGK has



facilitated collection and incineration facility to hospitals through private contractor(s) operating at one or two incineration plants[3].

## **Literature Review**

### **Concept of Solid Waste Management**

The source of waste; the producer, its generation; quantities, volumes and characteristics of wastes all are essential to determine and critical for the designing, planning and operation of solid waste management system.

### **Definition of Solid Waste**

It includes all types of semi-solid and solid waste arising due to human or animal activity as well as due to natural calamity(s) that is useless / undesirable / unwanted or regarded as discarded material requiring removal and subsequent disposal. Usually if not removed from the source of generation or disposed off properly may of potential hazard to environment (life and property).

Waste is a relative term i. e. for one it may be useless or unwanted but for someone it may be a useful item (a commodity – recovery, reuse, recycling)

### **Defining Solid Waste Management**

It is the integration of various activities associated with solid waste into well defined and coordinated manner to optimise the use of human, physical and economic resources and to prepare for the future needs. Solid waste management are the principles and practices comprised of effective management tools applied to different components of solid waste processes which include; collection, storage, transportation, treatment and safe disposal.

A comprehensive definition of SWM may be given as:

It is a discipline associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations, and that is also responsive to public attitudes.

There are a number of concepts about waste management which vary in their usage between countries or regions. Some of the most general, widely-used concepts include:

- Waste hierarchy refers to the “ 3 Rs” reduce, reuse & recycle, which classify waste management strategies according to their desirability in terms of waste minimization. The waste hierarchy remains the cornerstone of most waste minimization strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste.
- Extended producer responsibility (EPR) is a strategy designed to promote the integration of all costs associated with products throughout their life cycle (including end-of-life disposal costs) into the market price of the product. Extended producer responsibility is meant to impose accountability over the entire lifecycle of products and packaging introduced to the market. This means that firms which manufacture, import and/or sell products are required to be responsible for the products after their useful life as well as during manufacture.

- Polluter pays principle (PPP) is a principle where the polluting party pays for the impact caused to the environment. With respect to waste management, this generally refers to the requirement for a waste generator to pay for appropriate disposal of the waste.

### **Hierarchy of Solid Waste Management in Karachi Metropolis**

As defined above waste hierarchy means classification, according to the facet of ' desirability', of waste management strategies. The strategies could be to reduce waste or to reuse, recovery waste or intention to recycle waste, the ' 3 Rs' of waste management. Another recent strategy is to ' rethink' or review the present system for an improved system. Whatever the classification, the main and sole object of waste management is to treat and dispose waste completely or minimize it from the environment, to safeguard the health of the community. Concurrently, the supplementary object is to extract maximum benefits from the waste by turning it in to a useful product.

In case of Karachi these elite goals are still to be defined and strategies laid as the primary task of cent percent collection of solid waste and its disposal i. e. providing waste management services to entire metropolis area is yet to achieve.

### **Waste Source Reduction and Segregation**

No information from official sources is available on this subject. There is no scheme launched by the solid waste management department of the district government to promote waste reduction of municipal solid waste at household level neither citizens are encouraged to segregate the waste into ' recyclables' or ' non-recyclables' at source. However public in their own

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interest for some financial gain with collaboration and cooperation of informal sector domestic & commercial waste producers ' segregate and sell' their disposable or ' recyclable' waste items to ' door-to-door' collectors ' kabadis'. Similarly, industries sell and dispose their waste to middle dealers and recyclers. Also a large volunteer force of waste pickers on mobilised on streets is operational as ' scavengers'. These are mainly self employed labour of Afghan origin who collect recyclables from streets, community bins and open areas on daily basis sale to middle dealer to onward sale to recyclers. Hence a very strong system of waste recovery from general solid waste stream and subsequent recycling exists in the informal sector which is playing its part in the management of solid waste and reducing the burden on the overloaded formal sector of SWM but unfortunately its role has neither been recognised nor acknowledged.

### **Integrated Solid Waste Management System**

It is a methodology for solid waste management applied to all of the activities associated with the management of society's waste. The term integrated implies that the activities are interdependent and inter-related so as to formulate a comprehensive and effective waste management system.

Integrated Solid Waste Management may be defined as:

It is the selection and application of suitable techniques, technologies, and management programmes to achieve specific waste management objectives and goals.

The basic aim of the integrated solid waste management is to manage solid waste in a manner that meets public health and environmental concerns and the public's desire to reuse and recycle waste materials.

### **Hierarchy of Integrated Solid Waste Management**

A hierarchy (arrangement in order of rank) in waste management can be used to rank actions to implement programmes within the community. The integrated solid waste management hierarchy used may be sequenced as;

- Source reduction,
- Recycling,
- Collection
- Waste transformation and
- Disposal

ISWM programmes and systems should be developed in which the elements of hierarchy are interrelated and are selected to support each other.

### **The Functional Elements of Solid Waste Management.**

The Functional Elements of a Waste Management System may be classified as those activities which take place within the system to meet the targets and objectives defined for the effective management of the solid waste. The components are those which are acquired and or physically developed (work force, infrastructure & facilities, resources, etc.) to facilitate the functions of the SWM system. The typical functional elements of SWM in an urbanised developed sector may be listed as follows:

- Waste generation
- Waste handling and separation, storage and processing at source

- Collection
- Separation and processing and transformation of solid wastes
- Transfer and transport
- Disposal

### **Waste Generation**

It encompasses activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal. It is important in waste generation to note that there is an identification step and that this step varies with each individual waste. At present waste generation activity is not very controllable, however, it is expected that more control will be exercised over waste generation in future.

As already mentioned that waste generation phenomenon is dependent upon the demographic characteristics of town or city particularly the changing demography i. e. the population due to growth and expansion with modernisation and urbanisation process.

### **Solid Waste Generation in Karachi**

In case of Karachi the devolution of city administration in towns though 'ease off' the administrative bottle necks to certain extent particularly in context to management of public services but with solid waste management which is more or less demographically controlled system the magnitude of the problem is not much reduced. It would therefore be appropriate to present the generation rates municipal solid wastes of different towns of Karachi in perspective of their respective populations for certain year of study and projected likewise.

As established the quantities of solid wastes depend upon the demographic characteristics and its composition is highly variable factor attributed to socioeconomic features as well as waste management practices. The overall composition of solid waste determined at household level is given as follows:

### **Estimated Per Capita Waste Generation Rate in Karachi**

According to survey carried out in 2005 waste generation rate is estimated as 0.3 to 0.5 kg/capita/day. It is to be understood that generally the waste generation rate depends upon a number of factors such as:

- Income level of waste producer
- Socioeconomic and living style
- Festive occasions
- Waste management policies and programmes
- Awareness & education about environment and waste concerns

### **Sources of waste generation in Karachi**

In case of Karachi, sources of waste generation may be categorized as under:

- Domestic
- Commercial,
- Green wastes
- Hospital
- Industrial

The types of wastes or garbage generated are: household, commercial, institutional and street sweepings. On the basis of nature of waste it is classified as degradable (organic), non-degradable (recyclable / non-

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recyclable). The estimated figures given in the SWM document of Karachi Master Plan 2020 draft report 2005 are as follows:

Major markets where organic waste is generated are:

- Vegetable market: 100 ton per day,
- Empress market: 70 tons per day

High-income localities generate garbage:

- Organic Waste: 60%
- Garden Waste: 12%
- Recyclables: 8%

Low-income localities generate garbage:

- Organic Waste: 40%
- Garden Waste: 5% (max)
- Recyclables: 15%

The solid waste generate that is recovered at;

- Household level,
- Community bin level (prior to transfer / transportation) and
- Disposal site

### **Waste Handling and Separation, Storage and Processing at Source**

Waste handling and separation involves the activities associated with management of wastes until they are placed in storage containers for collection. Handling also encompasses the movement of loaded containers to the point of collection. Separation of waste components is an important step in the handling and storage of solid waste at the source. The best place to

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separate waste materials for reuse and recycling is at the source of generation. Processing at the source involves activities such as compaction and yard waste composting.

### **Collection**

Collection includes not only the gathering of solid waste and recyclable materials, but also transport of these materials, after collection to the location where collection vehicle is emptied. This location may be materials processing facility, a transfer station, or a landfill disposal site. In small cities, where disposal sites are nearby, the hauling of wastes is not a serious problem. In large cities, however, where the haul distance to the point of disposal is often greater than 15 miles, the haul may have significant economic implications. Where long distances are involved, transfer and transport facilities are normally used.

### **Collection and Transportation of Solid Waste in Karachi**

Stages of collection of garbage is from house hold to community bin sites, (kachra kundi) and then to disposal sites. This is done in the following ways:

- Stage 1: From house MSW is collected by private sweepers and resident brought to temporary storage / communal waste transfer facility i. e. community bins.
- Stage 2: From dust bins municipality vehicles transfer and transport solid waste to disposal sites OR to unofficial dumping ground (Primary transportation, 2-3 trips a day which by definition are long trips)

### **Problem Analysis**

This is the most uneconomical way of SWM because the haulage is extraordinarily long and several vehicles have to make this long trips several times a day. Hence due to shortage of infrastructure and physical & human resources with handling of large quantities of waste required the SWM becomes inefficient in handling, transporting and disposing waste effectively.

The following problems arise in Karachi in primary collection:

- Poor attendance of sanitary workers. Estimated number of employed sanitary workers employed in CDGK is 12000.
- Gradual decrease in number of community bins (4100), as a large number of garbage containers Katchra Kundi are in the workshop for repairs.
- Haphazard accumulation of garbage on streets, in open spaces and in drains.
- Uncollected waste usually finds its way in sewers, is eaten by the cattle, or left to rot in the open, or burnt on roadsides
- 15 to 20% garbage vans remain out of order. Total number of waste vehicles estimated is 560.
- Landfill sites are situated at long distance ranging from 10 to 70 km (up & down)
- Hardly 300 to 400 trips of garbage vehicles are off loaded daily at landfill sites out of 1500 trips.

### **Transfer and Transport**

This involves two steps; the transfer of waste from the smaller collection

vehicle to the large transport equipment, and the subsequent transport of  
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the wastes, usually over long distances, to a processing or disposal site. The transfer usually takes place at a transfer station. Although motor vehicle transport is most common, rail cars and barges are also used to transport waste. The two systems for transfer and transporting solid waste through roads comprises of hauled and stationary container system.

### **Transfer and Transport of Garbage in Karachi – Past Experiences**

In mid 90s an experiment of using train carriages was done for hauling MSW of Karachi by the name of Garbage Train project. The project was launched by defunct KMC in 1995-1996. Garbage from Saddar, Lyari and other adjacent areas was brought to Wazir Mansion Railway station for onward transportation to Dhabeji through railway. The system ran for about 4 to 5 months. Rs 27 Million were spent on the project. The system failed due to:

- High charges levied by railway authorities
- Wagons provided by the railway authorities were obsolete (not in good service condition)
- No proper infrastructure for loading & unloading of garbage could be developed at transfer stations.

### **Processing and Recovery of Solid Waste**

It includes the recovery of separated materials, the separation and processing of solid waste components, and transformation of solid waste that occurs primarily in locations away from the source of waste generation. The types of means and facilities that are now used for recovery of waste materials that have been separated at source include kerbside collection, drop off, and buy back centres.

The separation and processing of wastes that have been separated at source and the separation of commingled wastes usually occur at a materials recovery facility, transfer stations, combustion facilities, and disposal sites.

Processing often includes the separation of bulk items, separation of waste components by size using screens, manual separation of waste components, size reduction by shredding, separation of ferrous metals using magnets, volume reduction by compaction and combustion.

Transformation processes are used to reduce the volume and weight of waste requiring disposal and to recover conversion products and energy. The organic fraction of MSW can be transformed by a variety of chemical and biological processes. The most commonly used chemical transformation process is combustion which is used in conjunction with the recovery of energy in the form of heat. The most commonly used biological transformation process is aerobic composting. The selection of a given set of processes will depend on the waste management objectives to be achieved.

### **Processing of Organic Waste in Karachi – An experiment**

A compost plant was established in the early 80's by a private contractor in North Karachi which remained operative for a short period and then was closed down due to following reasons:

- Supply of non-segregated refuse, gradually damaged the plant.
- Heavy operational losses.
- Gained favour during import of plant machinery and also acquisition of land for installation of the plant, as such there was not much financial stake of the contractor was involved.

- Deployment of untrained and unskilled staff.
- Non-cooperation from the municipal administration (informal sources).

### **Disposal of Solid Waste**

It is the final functional element in the solid waste management system.

Nowadays, the disposal of wastes through landfill or land-spreading is the ultimate fate of all solid wastes, whether they are residential wastes collected transported to a landfill site, residual materials from materials recovery facilities (MRFs), residues from the combustion of solid waste, compost, or other substances from various solid waste processing facilities.

A modern sanitary landfill is not an open dump; it is an engineered facility used for disposing of solids on land or within the earth's mantle without creating nuisances or hazards to public health or safety.

Landfill or more specifically sanitary landfill is an engineering term, which may be defined as:

An engineered facility developed on a designated piece of land that principally receives waste as a 'fill' over a period of time until the designated area is fully utilised. The development and operation of facility is usually cost effective while maintaining appropriate health, safety and environmental standards.

### **Sites for Solid Waste Disposal in Karachi**

Only two official landfill sites available and are in use in the city are:

- Jam Chakro near Surjani Town (500 acres)
- Gondpass near Hub river Road (500 acres)

In addition to the above two marked sites, CDGK also acquired Dhabeji Landfill site (3000 acres) through notification of 2006 for the purpose of landfill operations in 2007 but the operations could not commenced due to administrative and financial constraints.

Earlier the project of the Transfer and Disposal of Karachi City through Garbage (Kachra) Train started in mid 90s which used open and closed cargo wagons to transfer collected MSW from garbage transfer station (Wazir Mansion) hauling it to Dhabeji site for open dumping / disposal. The project was also not successful and ceased due to administrative issues and financial